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Canadian Science Advisory Secretariat
Science Advisory Report 2008/023

2008 ASSESSMENT OF 4VWX HERRING

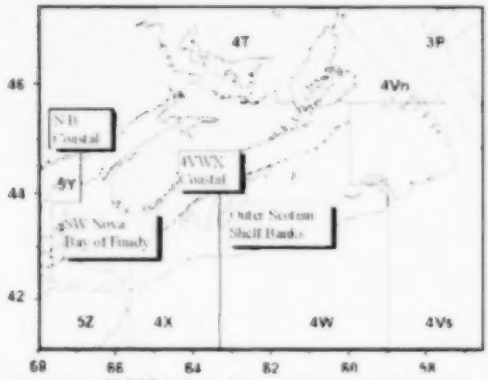

Figure 1. 4VWX herring management area and stock component locations.

Context:

In support of scientific advice for the 2007/08 fishery, the 2008 assessment of the 4VWX herring stock complex was undertaken by the Regional Advisory Process. The meeting was held March 17, 2008, in Moncton, N.B. to review and evaluate biological and fishery information on 4VWX herring status as a basis for establishing quota for the 2007/2008 fisheries, as required in the Integrated Fisheries Management Plan. The terms of reference included an evaluation of the SW Nova Scotia / Bay of Fundy spawning component, compilation and review of information regarding the offshore Scotian Shelf and the coastal Nova Scotia spawning components, an update on southwest New Brunswick migrant juvenile fishery component, an update of progress to date with ageing studies and workshop held in January 2008, analysis of impacts of harvesting on size and age and the long-term effects on biomass and recommendations to management regarding catch levels. Participants included scientists, fishery managers, and representatives of the industry, provincial governments and other stakeholders.

The 2003-2006 Scotia-Fundy Herring Integrated Fisheries Management Plan (DFO 2003) set out principles, conditions, and management measures for the 4VWX herring fisheries. The main principle stated in the plan is "the conservation of the herring resource and the preservation of all of its spawning components". Three conservation objectives appear in the plan:

1) *To maintain the reproductive capacity of herring in each management unit through:*
   - *persistence of all spawning components in the management unit;*
   - *maintenance of biomass of each spawning component above a minimum threshold;*
   - *maintenance of a broad age composition for each spawning component; and*
   - *maintenance of a long spawning period for each spawning component.*
2) *To prevent growth overfishing:*
   - *continue to strive for fishing mortality at or below $F_{0.1}$*
3) *To maintain ecosystem integrity/ ecological relationships ("ecosystem balance"):*
   - *maintain spatial and temporal diversity of spawning*
   - *maintain herring biomass at moderate to high levels*

Progress against these objectives was evaluated at this meeting. Since 1995, the herring stock assessment and related research has been increasingly dependant on a number of projects undertaken with the assistance of the fishing industry. These include industry sampling of biological characteristics of the catch, as well as acoustic surveys using industry vessels and tagging. A major review of the assessment framework including aspects of stock structure, sampling and tagging results, acoustic surveys and design was completed in the fall and winter of 2006-07 (DFO 2007). Evaluation and review of assessment formulations and alternative models/approaches is yet to be completed.

SUMMARY

SW Nova Scotia / Bay of Fundy

- Landings in 2006/07 were 50,400t against a TAC of 50,000t for the SW Nova Scotia / Bay of Fundy component. Landings have tracked the TAC in recent years with most of the quota being taken each year since 2002.
- There has been an increase of older/larger fish in the catch but the percentage is well below pre-1999 levels. The number of smaller fish in the catch (less than 23cm) were similar to other years. Small fish were seen in abundance in both the stock fishery and in New Brunswick weirs suggesting a strong year-class.
- Biomass estimates in the traditional survey areas for Scots Bay, Trinity Ledge and German Bank were 384,400t, which is an increase of approximately 100,000t from 2006. The index from acoustic surveys has increased by 64% over the last two years, is at a moderate level, and is 12% below the average of the nine year series.
- Fishing mortality was not determined but appears to be decreasing based on the trends from relative exploitation rates from acoustic surveys.
- Some conservation objectives specified for this fishery are being met but there are still concerns with spawning areas other than German Bank.
- This assessment indicates an improvement from the low level of the resource noted in recent assessments. A harvest strategy that exercises continued caution to facilitate further rebuilding is strongly recommended.
- The potential benefits of the quota and other rebuilding measures from 2005 through to 2007 are now starting to be reflected in improved biological characteristics of the population.

Offshore Scotian Shelf Banks

- Since 1996, a fishery has taken place on feeding aggregations on the offshore banks, primarily in May and June, with catches ranging from 1,000 to 20,000t. Total landings were down to 5,400t in 2007 from 9,800t in 2006.
- There is little new information to add and no reason to change the previous recommendation that the initial catch allocation for 2008 should not exceed the 12,000t as described in the fishing plan.
- The industry has been encouraged to explore and undertake structured surveys of the offshore area but this has not occurred in recent years.

Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia

- In 2007 there was a reduction in surveyed acoustic biomass in the Halifax/Eastern Shore area of about 50%. The Little Hope area saw an even larger decline of almost 90% from the previous year.
- Management approaches and recent research efforts have improved knowledge in three areas (Little Hope/Port Mouton, Halifax/Eastern Shore and Glace Bay), but there has been no increase in knowledge in adjacent areas. Surveys were also completed near Glace Bay but there were very little spawning herring documented or catch reported.
- There should be no large increases in effort in coastal spawning areas and no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing.
- The decline in or lack of surveyed biomass of all three major coastal spawning groups is cause for concern. It is recommended that given the current situation of declining biomass in all areas the "survey, assess, then fish" protocol should be reinstated.

SW New Brunswick Migrant Juvenile

- These fish have been considered to be a mixture of juveniles, dominated by those originating from NAFO Subarea 5 spawning components, and have therefore been excluded from the 4WX quota.
- The landings for the 2007 New Brunswick weir and shutoff fishery were 30,921t which is the highest catch for this component since 1993.

BACKGROUND

Species Biology

Atlantic herring is a pelagic species found on both sides of the North Atlantic. Herring spawn in discrete locations, to which they have a strong affinity. Herring mature and first spawn at three or four years of age (23 to 28cm or 9 to 11in), then begin an annual pattern of spawning, over-wintering, and summer feeding, which often involves considerable migration and mixing with members of other spawning groups. Most fishing takes place on dense summer feeding, over-wintering, and spawning aggregations.

The 4VWX management unit contains a number of spawning areas, separated to various degrees in space and time. Spawning areas in close proximity with similar spawning times, and which share a larval distribution area, are considered part of the same component. These undoubtedly have much closer affinity than spawning areas that are widely separated in space or time, and do not share a common larval distribution. Some spawning areas are large and offshore, whereas others are small and more localized, sometimes very near shore or in small embayments. The situation is complicated further as herring migrate long distances and mix outside of the spawning period both with members considered part of the same component and with members of other components. For the purposes of evaluation and management, the 4VWX herring fisheries are divided into four components:

1. SW Nova Scotia / Bay of Fundy spawning component
2. Offshore Scotian Shelf banks spawning component
3. Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia spawning component
4. SW New Brunswick migrant juveniles

Each component except SW New Brunswick migrant juveniles has several spawning areas, and there is mixing of fish among spawning components outside of the spawning period.

Fishery

Fisheries in the 4VWX area in recent years have been dominated by purse seine, weir and gillnet, with relatively minor landings by shutoff and trap.

Landings in 2006/07 were 50,400t against a TAC of 50,000t for the SW Nova Scotia / Bay of Fundy component (Table 1). Landings have tracked the TAC in recent years with most of the quota being taken each year since 2002 (Figure 2). There were additional landings of 41,600t in the non-stock components for an area total of 91,900t with an increased proportion of catches from the New Brunswick weirs in 2007. Catches by fishing grounds were similar to recent years with the largest proportions from the German Bank and Grand Manan areas. There was an increase in catches from the Gannet/Dry Ledge area adjacent to German Bank and below average catches from Scots Bay and the Long Island shore area.

Industry and management have explored means of managing the complexity within each component (such as distributing fishing effort among spawning areas according to their relative size) and taking appropriate account of the interaction among components (such as fishing restrictions on some areas of mixing). Prior to 2005, there was targeting of young fish and the high proportion of juveniles in the catch resulted in lost potential yield. In 2005/2006 industry made a concerted effort to re-direct to larger fish which resulted in a significant decrease in the proportion of fish less than 23cm in the catch. This, combined with the reduced TAC, has allowed the proportion of adult fish from 23 to 30cm to increase (Figure 3). The total removals of fish by numbers have also been reduced by close to 50% in 2005/2007 relative to 2004.

Table 1. Reported landings (thousands of tonnes) and TAC for the 4WX herring management unit by component from 2000 to 2007 with averages for prior decades.

Year	Average 1980-89	Average 1990-99	2000	2001	2002	2003	2004	2005	2006	2007
4WX SW Nova Scotia TAC*	106	112	100	78	78	93	83	50	50	50
4WX SW Nova Scotia*	131	96	85	72	77	89	78	49	50	50
4VWX Coastal NS^	<1	4	4	6	10	9	7	7	7	5
Scotian Shelf Banks^	<0.1	13	2	12	7	1	4	5	10	5
SW New Brunswick^	24	24	17	20	12	9	21	13	13	31
Total Landings	155	137	108	110	106	108	110	74	79	92

* Quota year from Oct. 15 of the preceeding year to Oct 14 of the current year

^ Calendar year from Jan. 1 to Dec. 31

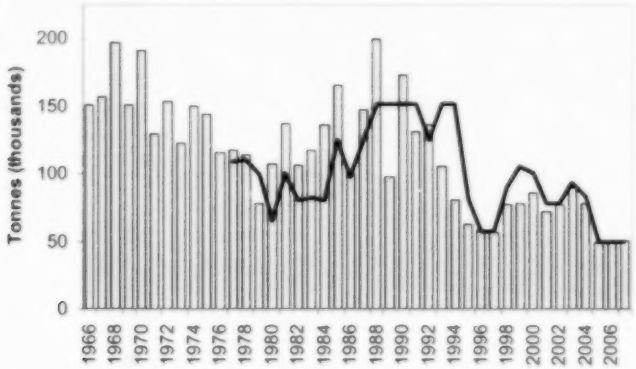

Figure 2. Landings (thousands of tonnes) and TAC for the SW Nova Scotia / Bay of Fundy spawning component.

ASSESSMENT FOR THE SOUTHWEST NOVA SCOTIA / BAY OF FUNDY SPAWNING COMPONENT

In 2007 the catch at length size composition was comprised of 46% fish less than 23cm (23cm = length at which 50% are mature), 49% fish 23 to 30cm and 5% sizes larger than 30cm (approx. 5-6 years old) (Figure 4). There has been an increase of older/larger fish in the catch but the percentage is well below pre-1999 levels. The number of smaller fish in the catch (less than 23cm) were similar to other years. Small fish were seen in abundance in both the stock fishery and in New Brunswick weirs suggesting a strong year-class. The proportion of the catch greater than 30cm increased in 2007 to 5% from 2% in 2006 (Figure 3). The total number of fish removed by the fishery was estimated to be 50% less in 2006/2007 (411 million) relative to 2004 (821 million).

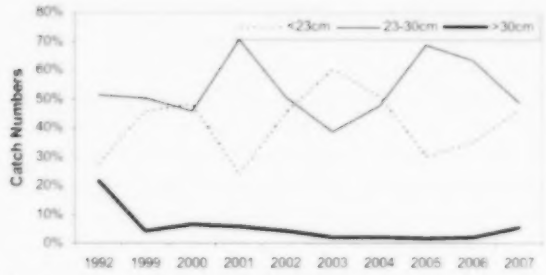

Figure 3. Proportions of size groups (% number) <23cm, 23-30cm and >30cm herring in the catch from the SW Nova Scotia / Bay of Fundy spawning component.

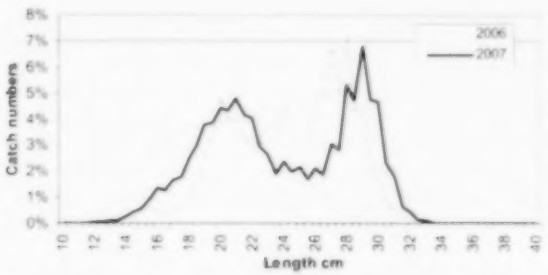

Figure 4. Catch at length (% number) for the 2006 and 2007 overall SW Nova Scotia / Bay of Fundy herring spawning component.

Acoustic Surveys

Industry led surveys with automated acoustic recording systems deployed on commercial fishing vessels were used to document the distribution and abundance of herring. Scheduled surveys were conducted every 2 weeks on the main spawning components and an index of spawning stock biomass (SSB) for each component was estimated by summing these results (Table 2).

A major source of uncertainty continues to be the assumption that the surveys are simply additive. If herring do not move on to and off of the spawning grounds in waves, the estimate of total SSB will be biased; upward due to double counting or downward due to the missing of waves. As well, herring have been observed close to bottom, which can lead to an under-estimation of biomass from acoustic surveys. Other significant issues relate to the completeness of coverage of the survey area, inter-annual turn-over processes on each area, the dead zone at both surface and bottom, and factors that influence the target strength and acoustic backscatter (DFO 2007).

Four surveys were conducted in Scots Bay in 2007. The duration of the spawning fishery period in Scots Bay was extended through the entire season. Four usable surveys were also completed on German Bank. The duration of the spawning fishery on German Bank was similar to previous years but ended in early October due to the lack of quota. Additional acoustic data from fishing nights on German Bank were examined but not included in the overall biomass estimate. Individual survey area coverage was good and consistent with established protocols.

The amount of spawning fish documented on Trinity Ledge was extremely low but survey coverage was improved. There were no surveys and no reports of spawning herring around Seal Island and Browns Bank grounds. A small spawning fishery occurred on Spectacle Buoy in June with limited survey effort.

Table 2. Acoustic survey biomass index for SW Nova Scotia / Bay of Fundy spawning component for 1999 to 2007 ('000's t). Blanks indicate that no survey was undertaken. Estimates are calculated without the use of the integration calibration factor.

Location/Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average
Scots Bay	41	106	164	141	134	108	17	29	46	87
German Bank	461	356	191	393	344	368	211	246	337	323
Trinity Ledge	4	1	15	8	15	7	5	9	1	7
Spectacle Buoy (spring)			1		1		0.3			1
Spectacle Buoy (fall)			88							88
Subtotal	506	463	458	542	493	482	233	283	384	427
German (outside box)								4		4
Seal Island			3	1	12			8		6
Browns Bank			46					6		26
Overall SSB	506	463	507	543	506	482	233	301	384	436
Overall SE % *	19	14	10	9	17	15	28	16	16	16

* Overall SE% is the percentage of the standard error of the estimate to the mean.

Biomass estimates in the traditional survey areas for Scots Bay, Trinity Ledge and German Bank were 384,400t, which is an increase of approximately 100,000t from 2006. While the acoustic biomass is greater than in 2006 it still remains below the average for 1999-2007 (Figure 5). The overall biomass index estimated from acoustic surveys in 2007 represents an increase of 28% from 2006. The index from acoustic surveys has increased by 64% over the last two years, is at a moderate level, and is 12% below the average of the nine year series.

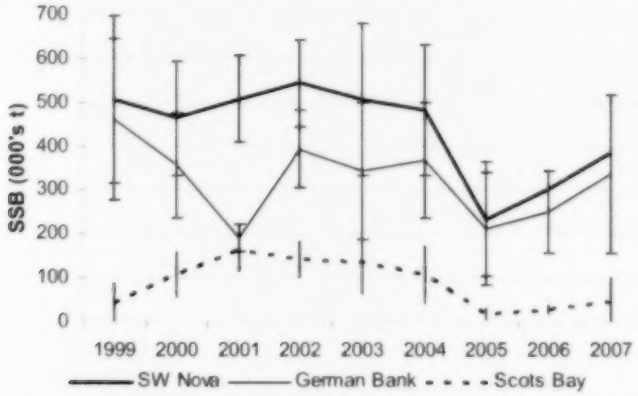

Figure 5. SSB index from acoustic surveys for the SW Nova Scotia / Bay of Fundy spawning component, and for Scots Bay and German Bank areas.

Stock Trends and Current Status

The 2005 assessment compared a population model (Virtual Population Analysis, VPA) calibrated using the relative abundance from the acoustic surveys with the absolute abundance estimated from these same acoustic surveys. While the trends in modeled abundance followed those in the survey, there was an inconsistency in that a lower estimate of biomass was determined by the VPA compared with the absolute estimate provided by the acoustic surveys. The 2007 framework review (DFO 2007) concluded that while the current acoustic survey can only provide a relative index of abundance, efforts should continue towards developing an absolute estimator.

The January 2008 herring ageing workshop concluded that there are major inconsistencies with herring ageing amongst the readers and with the historical database. The degree of difference varies depending upon the reader. The current 4VWX otoliths have been consistently under aged relative to the other readers and the database. The implication, or impact, of under ageing on a VPA has been examined by several investigations over the past couple of years (Melvin and Power 2007). The results from these studies indicate that under ageing leads to an over-estimate of fishing mortality and an under estimate of biomass; the amount dependent upon the severity of the under ageing. As a result, an age based analytical assessment with estimates of fishing mortality cannot be undertaken until the ageing issues are resolved.

Between 1999 and 2003, acoustic survey results were used as minimum estimates of absolute SSB abundance and the population was considered to be approximately 500,000t. An SSB of that size would have been expected to result in substantial growth of the population, improved age composition and low fishing mortality, given reasonable recruitment and the landings over that period. The expected increase in the SSB due to the reduced quota is now being observed in the surveys.

There are several positive signals for this component. Fishing mortality was not determined but appears to be decreasing based on the trends from relative exploitation rates from acoustic surveys (Figure 6). There are indications that a strong year-class may be entering the fishery with a large number of smaller fish in the catch (less than 23cm) that were seen in both the stock fishery and in non-stock New Brunswick weirs. There has also been an increase in acoustic survey biomass in recent years, but the stock biomass remains below historical levels.

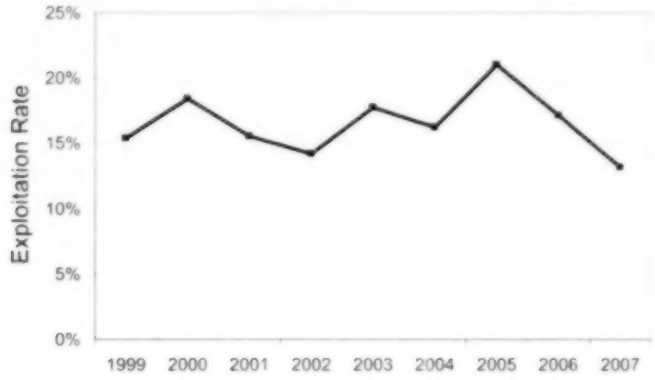

Figure 6. Relative exploitation rate for the SW Nova Scotia / Bay of Fundy spawning component using overall catch as a proportion of the overall acoustic SSB.

Sources of Uncertainty

- There is uncertainty related to the use of the acoustic survey results as a measure of absolute abundance including: residency time on the spawning grounds and estimation of biomass in the acoustic dead zones at the surface and close to bottom..
- There is uncertainty with age determinations of 4+ herring for this stock which is under review.
- There is no independent index of recruitment and a large fraction of the catch is dependent on recruiting year classes.
- There are substantial numbers of smaller fish (between 18-23cm) that may represent a strong incoming year-class.

CONCLUSIONS AND ADVICE

The objectives for this stock from the management plan and the current observations are summarized below. Some conservation objectives specified for this fishery are being met but there are still concerns with spawning areas other than German Bank.

Objective	2007: Observations
Persistence of all spawning components	Biomass increases in Scots Bay and German Bank. Spawning not observed on Seal Island. Trinity Ledge is at the lowest recorded.
Maintain biomass of each component	German Bank biomass estimate is now at or above average. Scots Bay, Trinity Ledge and Seal Island remain well below average or at very low biomass.
Maintain broad age composition	Proportion of larger (30cm+) sizes has increased consistent with average growth rates. Age composition is still assumed to be truncated with few larger fish in the population. The presence of a possible strong year-class with 18-23cm size range abundant in both the New Brunswick weir and purse seine fisheries.
Maintain long spawning period	Start and duration of spawning in 2007 for German Bank and Scots Bay was typical but not for Trinity Ledge.
Fishing mortality at or below F0.1	Fishing mortality was not determined but appears to be decreasing based on the trends from relative exploitation rates from acoustic surveys.
Maintain spatial and temporal diversity of spawning	Insufficient spawning in all areas except for German Bank and Scots Bay.
Maintain biomass at moderate to high levels	SSB index from the acoustic surveys has increased by 64% over the last two years, is at a moderate level, and is 12% below the nine year average.

This assessment indicates an improvement from the low level of the resource noted in recent assessments. A harvest strategy that exercises continued caution to facilitate further rebuilding is strongly recommended. Despite the increase in acoustic SSB and the improved proportion of larger fish, catch levels should remain near the current status quo due to uncertainties in estimating SSB, recruitment and the exploitation rate for this stock.

OTHER CONSIDERATIONS

The potential benefits of the reduced quota and other rebuilding measures from 2005 through to 2007 are now starting to be reflected in improved biological characteristics of the population.

The acoustic index provides fisheries independent information on the spawning stock biomass but does not provide data on younger age classes. The size of herring year-classes is highly variable and there is no index of recruitment. The increased and significant catches of small fish in the New Brunswick weirs from the 2005 cohort may indicate the presence of a strong year-class.

ASSESSMENT, CONCLUSIONS AND ADVICE FOR OTHER COMPONENTS

Offshore Scotian Shelf

Since 1996, a fishery has taken place on feeding aggregations on the offshore banks, primarily in May and June, with catches ranging from 1,000 to 20,000t (Figure 7). Total landings were down to 5,400t in 2007 from 9,800t in 2006 with most landings by purse seine and midwater trawl in May and June, in the vicinity of the Patch, Emerald and Western banks. There was also effort near the shelf edge, west of Sable Island, by midwater trawlers.

In 2007, the size composition of the catch was mostly adult fish >23cm (50% maturity at length) with a substantial proportion (27%) larger than 30cm (see highlighted bars Figure 8).

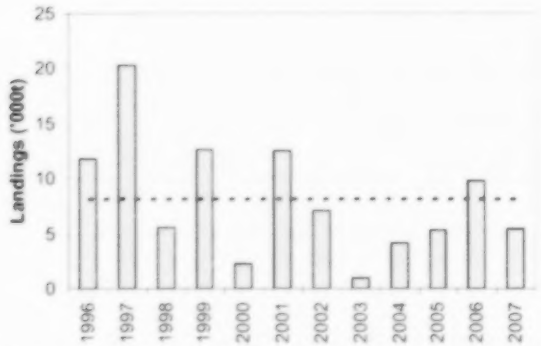

Figure 7. Offshore Scotian Shelf herring landings since 1996 with overall average for the period.

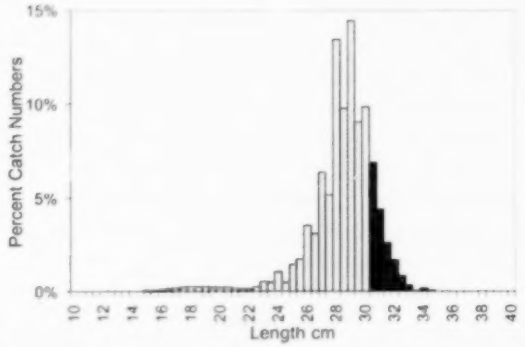

Figure 8. Catch at length (% numbers) for the 2007 Offshore Scotian Shelf herring component.

There have been no industry surveys of the offshore Scotian Shelf area since 2001. The summer bottom trawl research survey index which previously demonstrated considerable abundance of herring widely spread over the Scotian Shelf, has declined substantially from the high of 2004. The bottom trawl data are not considered indicative of overall herring abundance.

There is little new information to add and no reason to change the previous recommendation that the initial catch allocation for 2008 should not exceed the 12,000t as described in the fishing plan. The industry has been encouraged to explore and undertake structured surveys of the offshore area but this has not occurred in recent years.

Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia

There is no quota for the coastal Nova Scotia spawning component and, apart from four areas, the size and historical performance of various spawning groups are poorly documented (Table 3). In addition to the traditional bait and personal-use fisheries, directed roe fisheries have occurred on several spawning grounds in recent years.

Table 3. Recorded landings (thousands of tonnes) of herring from major gillnet fisheries on the Coastal Nova Scotia spawning component.

Landings	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Little Hope/Port Mouton		0.5	1.2	2.9	2.0	2.9	4.0	4.5	1.3	2.2	3.1	1.5
Halifax/Eastern Shore	1.3	1.5	1.1	1.6	1.4	1.9	3.3	2.7	4.2	3.4	3.3	3.7
Glace Bay		0.2	1.7	1.0	0.8	1.2	3.1	1.9	1.5	0.6	0.1	0.0
Bras d'Or Lakes	0.2	0.2	0.1	0.0	0.1							
Total	1.5	2.3	4.1	5.6	4.3	6.0	10.4	9.1	7.0	6.3	6.6	5.3

As the inshore roe fisheries off Glace Bay, East of Halifax and Little Hope have developed, participants have contributed to sampling and surveying of the fisheries.

The recorded landings of 5,300t in 2007 in the four major gillnet fisheries along the coast of Nova Scotia declined from 2006. They were much lower for Little Hope/Port Mouton area, had a small increase for the Eastern Shore area, were minimal for Glace Bay while the Bras d'Or Lakes area remained closed.

In 2007 there was a reduction in surveyed acoustic biomass in the Halifax/Eastern Shore area of about 50% from the previous year (Table 4, Figure 9). This was attributed by industry participants to a lack of survey effort in the Eastern Passage area and high turnover rates on the spawning grounds. The Little Hope area saw an even larger decline of almost 90% from the previous year (Table 4, Figure 10). There were no significant amounts of herring documented over the entire season on the normal spawning area near Port Mouton Island and the total biomass surveyed was only slightly more than the recorded catch. Surveys were also completed near Glace Bay but there were very little spawning herring documented or catch reported. (Figure 11). No herring surveys took place in the Bras d'Or Lakes.

Table 4. Estimated acoustic spawning survey biomass (thousands of tonnes) of herring for the Coastal Nova Scotia spawning component. Blanks represent no survey completed. Estimates are calculated without the use of the integration calibration factor.

Acoustic Survey SSB	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Little Hope/Port Mouton	14.1	15.8	5.2	21.3	56.0	62.5	15.6	39.5	21.7	2.4
Halifax/Eastern Shore	8.3	20.2	10.9	16.7	41.5	67.6	18.2	28.1	51.1	24.0
Glace Bay		2.0		21.2	7.7	31.5	0.0	2.2		0.1
Bras d'Or Lakes		0.5	0.1							

As indicated for the SW Nova Scotia / Bay of Fundy component, summing of multiple surveys may result in overestimates of SSB due to double counting. However, the majority of surveys of the Coastal Nova Scotia spawning component were undertaken on spatially separated aggregations of fish.

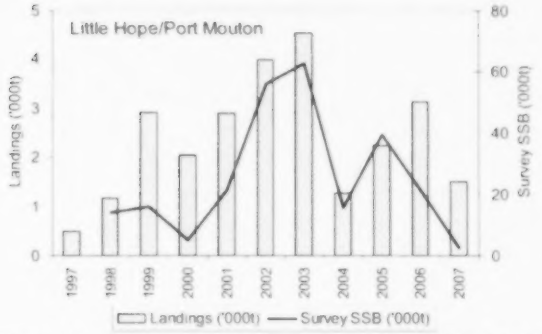

Figure 9. Landings and acoustic survey SSB ('000t) for the Little Hope/Port Mouton gillnet fishery for 1997-2007.

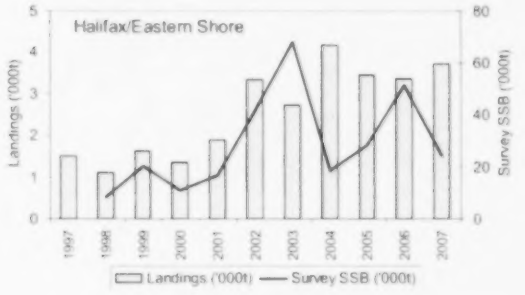

Figure 10. Landings and acoustic survey SSB ('000t) for the Halifax/Eastern Shore gillnet fishery for 1997-2007.

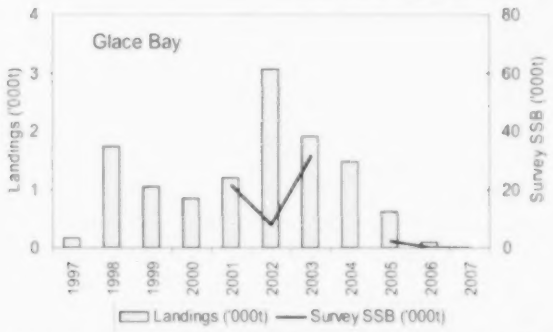

Figure 11. Landings and acoustic survey SSB ('000t) for the Little Hope/Port Mouton gillnet fishery for 1997-2007.

Management approaches and recent research efforts have improved knowledge in the three areas (Little Hope/Port Mouton, Halifax/Eastern Shore and Glace Bay), but there has been no increase in knowledge in adjacent areas. Individual spawning groups within this component are considered vulnerable to fishing because of their relatively small size and proximity to shore. As in the past five years, it is recommended that no coastal spawning areas experience a large effort increase until enough information is available to evaluate the state of that spawning group. There should be no large increases in effort in coastal spawning areas and no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing.

It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern. It is therefore appropriate to reiterate that no fishing should take place on this spawning component.

The decline in or lack of surveyed biomass of all three major coastal spawning groups is cause for concern. Recent management of these areas has used a five year average of recent catches and/or surveyed acoustic biomass to set removal levels. The provision to document sufficient quantities of fish each year before the fishery begins has been waived recently due to substantial abundances from previous years. It is recommended that given the current situation of declining biomass in all areas the "survey, assess, then fish" protocol should be reinstated.

SW New Brunswick Migrant Juveniles

The southwest New Brunswick weir and shutoff fisheries have relied, for over a century, on the aggregation of large numbers of juvenile herring (ages 1-3) near shore at the mouth of the Bay

of Fundy. These fish have been considered to be a mixture of juveniles, dominated by those originating from NAFO Subarea 5 spawning components, and have therefore been excluded from the 4WX quota.

In the previous assessment approximately 12,900t of herring were reported landed in the 2006 New Brunswick weir and shutoff fishery. The size of herring caught was abnormally small throughout the season and impeded markets. The 2007 assessment also showed a continued trend of decreasing number of weirs and landings over the most recent decade.

The landings for the 2007 New Brunswick weir and shutoff fishery were 30,921t which is the highest catch for this component since 1993 (Figure 12). The size composition of herring caught was well suited to the sardine market and was primarily of juvenile size with 95% by number less than 23cm (the size used to separate juveniles and adults) (see highlighted bars Figure 13). This also confirms the presence of the large 2005 year-class which was observed in large numbers in the previous season as small unmarketable fish. The number of active weirs with catch increased to 98 in the 2007 season from the low of 76 in 2005.

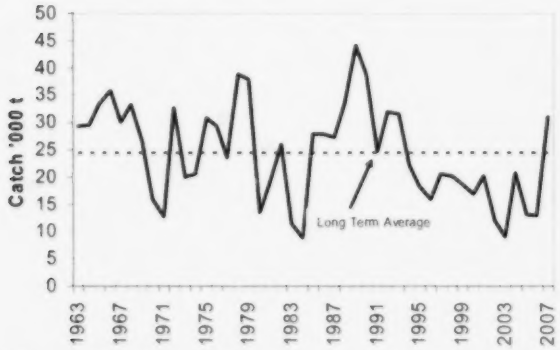

Figure 12. Herring landings from New Brunswick weir and shutoff fishery for 1963-2007 with long term average catch.

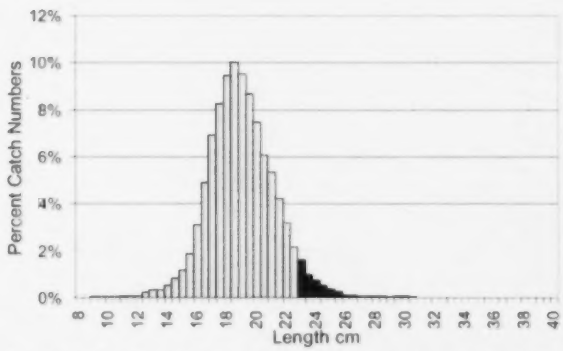

Figure 13. Catch at length (% numbers) for the 2007 SW New Brunswick migrant juvenile herring component.

SOURCES OF INFORMATION

DFO. 1997. In-Season Management in the 4WX Herring Fishery. DFO Maritimes Regional Fisheries Status Report 97/2 (1997).

DFO. 2003. 2003-2006 Scotia-Fundy Fisheries Integrated Herring Management Plan, NAFO subdivisions 4WX, 4Vn and 5Z. Department of Fisheries and Oceans.

DFO. 2007. Proceedings of the Maritimes Provinces Regional Advisory Process on the Assessment Framework for 4VWX Herring Stocks; 31 October – 1 November 2007 and 9 – 11 January 2007. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2007/002.

Melvin, G.D., and M.J. Power. 2007. Ageing Inconsistencies and Sensitivity Analysis for 4WX Herring. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/071.

Power, M.J., F.J. Fife, D. Knox, and G.D. Melvin. 2008. 2008 Evaluation of 4VWX Herring. DFO Can. Sci. Advis. Sec. Res. Doc. 2008/023.

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ISSN 1480-4913 (Printed)
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CORRECT CITATION FOR THIS PUBLICATION

DFO. 2008. 2008 Assessment of 4VWX Herring. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2008/023.